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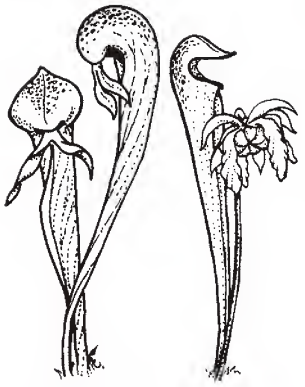

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Front Cover: Upper half: *Dionaea* habitat in the zone between a pocosin and longleaf pine savannah in the Green Swamp, Brunswick County, North Carolina in 1974. The young man in the photograph is Frank Lichtner studying the prey captured by *Dionaea*. Lower right: Another *Dionaea* habitat area, overgrown by grass that will eventually shade out the *Dionaea* if there is no fire. Lower left: A *Dionaea* plant in the Green Swamp (Cover of *Science* 1218(4577)10/12/1982. Reprinted with permission from AAAS). Article on page 44.

Back Cover: A three-year-old juvenile specimen of *Roridula gorgonias* in cultivation. Photo by Barry Rice. Article on page 74.

Carnivorous Plant Newsletter is dedicated to spreading knowledge and news related to carnivorous plants. Reader contributions are essential for this mission to be successful. Do not hesitate to contact the editors with information about your plants, conservation projects, field trips, or noteworthy events. Advertisers should contact the editors. Views expressed in this publication are those of the authors, not the editorial staff.

All correspondence regarding dues, address changes and missing issues should be sent to the Membership Coordinator at the ICPS. Do not send such correspondence to the editors. Checks for subscriptions should be made to the International Carnivorous Plant Society in US funds. Dues, including a subscription, are $30 per year.

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Mid-Atlantic Carnivorous Plant Society

The Mid-Atlantic Carnivorous Plant Society (MACPS) was recently formed in January 2017 as a group for all carnivorous plant enthusiasts living in Pennsylvania, Maryland, Delaware, New Jersey, and the surrounding area. Despite the abundance of carnivorous plant growers in these states, there are only a handful of CP nurseries and virtually no carnivorous plant shows. MACPS seeks to fulfill this gap by linking CP growers together through meetings, field trips, plant exchanges, and online conversation.

Anyone can become a member of the MACPS, and membership is free. We welcome you even if you're outside the mid-Atlantic region! We have both a website (www.macpsociety.com) and a Facebook page, as well as an online forum on the website.

We also invite you to our first meeting, which will be on Saturday, June 17, 2017 at Michael Szesze's Carnivorous Plant Nursery in Smithsburg, Maryland. Come meet the other CP growers in the area, trade some plants, participate in a carnivorous plant giveaway, and tour the nursery. We would love your help in planning this first meeting, and also invite you to give a short talk about any topic regarding carnivorous plants or their cultivation. To RSVP or if you have any questions, please email us at macpsociety@gmail.com.

—Kevin Zhang

THE

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an exclusive member benefit

The International Carnivorous Plant Society offers its members exclusive access to a variety of carnivorous plant seeds. Seeds are ordered online at the ICPS Store:

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Technical Refereed Contribution

Prey capture by *Dionaea muscipula*

A review of scientific literature with supplementary original research

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Keywords: *Dionaea muscipula*, Venus flytrap, habitat, prey attraction syndrome, alluring glands, nectar secretion, red color, scent, UV-reflection, fluorescence, size selection, capture rate.

Abstract: Many descriptions of prey capture by *Dionaea muscipula* (Venus flytrap) in popular publications and educational literature are inaccurate. Here we review well documented literature on prey capture in this plant's natural habitat and add observations on prey capture and attraction mechanisms we have observed in plants cultivated in a greenhouse and garden.

Despite its common name "Venus flytrap" does not specialize in capturing flies. About 70% of the prey it captures in its native habitat consists of spiders, ants, and beetles. Flies are only one-to-eighteen percent of what it captures. In a greenhouse where flies, capable of entering the vents, composed most of the available prey, over 90% of the prey captured were flies. *Dionaea* cultivated in a garden captured a diverse array of animals, only about 37% of which were flies. *Dionaea* is a generalist, capturing a wide variety of prey species. Its capture mechanism does not appear to have a "syndrome" analogous to the Pollination Syndrome in flowers where a specific floral type is pollinated by a specific animal (i.e. Bee Flowers or Fly Flowers).

The measured capture rates of *Dionaea* are low, about one capture/leaf/month in its native habitat. Similar but lower rates were measured in the greenhouse and garden. The single measurements in each habitat need to be repeated, but the low rates are consistent with the observation that wherever it is observed *Dionaea* has nearly all of its traps open. Both the low capture rates and the large number of open traps suggests that alluring agents drawing prey either do not exist or are ineffective.

Despite reports of nectar secretion by *Dionaea* traps, our observations show that unstimulated traps are always dry unless wet by rain, condensation, or a sprinkler system. Secretion occurs only after prey capture. Alluring glands along the outer trap margin have been reported to be visited by small ants that work their mouthparts over the glands. We have photographed a fly exhibiting the same behavior. The exact nature of this behavior needs to be further investigated, but it does not appear that this attractant can act at a distance since flies are as likely to land on the outside of a trap as on the inside.

Darwin proposed that the trap closure mechanism allows small prey to escape, preventing the expenditure of energy on captures likely to be of little benefit. Recent measurements of prey captures indicate that traps show little selectivity based on prey size and that while traps could, in theory, select larger prey, statistically they do not behave this way.

Introduction

What prey does *Dionaea muscipula* capture?

Any carnivorous plant can only capture prey that is present in its environment. If placed in a large terrarium with houseflies it can only capture houseflies. The prey present in the plant's habitat

will determine what the plant's traps can capture. However, other factors also determine what prey will be found in traps. Some carnivorous plants have been reported to have extra floral nectaries, attractive scents, and colors analogous to flowers. The relative attractiveness to prey would skew the proportion of each type of prey animal captured. The mechanics of the trap such as the ability to hold large prey, react quickly enough, etc. would also determine the type of prey captured.

It is the object of this paper to review the range of prey that is captured by *Dionaea* in various habitats and determine if characteristics of the trap might favor the capture of specific types of prey.

Most early observations of prey capture were likely conducted on plants cultivated in greenhouses or gardens far away from the plants' natural habitat and usually near human habitations. We will call these the greenhouse habitat and the garden habitat. The first early common name for *Dionaea*, "Catch Fly sensitive", used in a 2 April 1759 letter to Peter Collinson from Gov. Arthur Dobbs of North Carolina, infers that the plants primarily catch flies. Later Dobbs, in a 24 January 1760 letter to Collinson, calls the plant "Fly Trap Sensitive" (Nelson 1990). Subsequent early references to *Dionaea* refer to it as "Tipitiwitchet" which has no reference to the prey captured, but when John Ellis described the plant in the St. James Chronicle in 1-3 September 1773 he called it "Venus's flytrap" even though he knew that it captured many kinds of "little animals, such as Ear-wigs, Spiders and Flies" (Nelson 1990). For its scientific name Ellis proposed "*Dionaea Muscipula*, which may be construed into English, with humble submission both to Critics and foreign Commentators, either as Venus's Flytrap, or Venus's Mousetrap." The Latin species epithet *muscipula* actually means mousetrap, but the common name that took hold with the public was "Venus flytrap".

The name Venus flytrap infers that the prey of *Dionaea* consists of flies, which in a greenhouse with a population of flies, is what most of us who grow the plant observe. Most popular and educational descriptions of *Dionaea* also presume that flies are the major source of prey.

Methods

Prey capture measurements Natural Habitat (Lichtner & Williams 1978).

Leaves were collected in the field (Fig. 1 and Front Cover) from closed traps. For a thorough discussion of *Dionaea* ecology, see Roberts and Oosting (1958). The prey animals were identified in the field and preserved in alcohol. Specimens were reviewed in the laboratory to confirm the order to which they belonged.

Greenhouse Habitat

Two large *Dionaea* plants with traps up to five cm, a selective breeding by Klaus Ivanez (Germany), available in Germany and neighboring countries labeled with the additional designations "Predator" and "Destroyer" (not registered as cultivars) were in 10×10 cm pots (Fig. 2). Entrance of prey into the greenhouse was mostly restricted to the open vents, greatly favoring the entrance of agile fliers such as flies. The two plants had about 25-33 active traps. The eight prey captured previous to our study in reopened leaves were photographed and identified. During the following 36 days, 13 additional prey animals were captured and identified after the traps reopened.

Garden Pond Habitat

A population of *Dionaea* plants similar to those found in the wild had been established in a large pot with other carnivorous plants for about 20 years was used as the Garden Habitat. Access to prey incapable of flight was limited because the pot was effectively an island in the garden pond (Fig. 3). The population of plants had about 50 active leaves. The five prey captured previous to our study

Figure 1: Natural Habitat. Left: Zone between savannah and pocosin in the Green Swamp in North Carolina. The *Dionaea* in the foreground are marked with stakes for capture rate studies. Right: A close-up of one of the *Dionaea* plants.

in reopened leaves were photographed and identified. During the following 80 days, 58 additional prey animals were captured and identified after the traps reopened. In two captures, pairs of mating mosquitos were captured together. These were each logged as a single capture.

Capture rate measurements Natural Habitat (Williams 1980)

Plants in the field near Supply, North Carolina, USA were marked by placing a numbered potting stake nearby. The leaf nearest the potting stake was leaf 1. The leaves were numbered clockwise around the rosette notating the leaves that were closed (Fig. 1). Enough plants were staked to provide data from about 224 leaves. The leaves were observed just after dawn, at noon, the evening, and the following morning; closures of leaves were recorded. After the final observation the closed leaves were opened to determine if capture of prey had occurred. The traps were then tested to see if they were capable of rapid closure and 201 were. The number of closures with captures and closures without captures were recorded and the number of captures in 24 hours was computed.

Greenhouse Habitat

The traps were photographed daily for 36 days during which there was an average of 29.2 active traps. The observations were ended after 36 days because the weather had cooled enough that the greenhouse vents did not open and insects were not able to easily enter. Monitoring during the next

Figure 2: Greenhouse Habitat. Above: The large *Dionaea muscipula* available in some European countries with the additional designations "Predator" (left) and "Destroyer" (not registered as cultivars) are on the bench in the foreground (white box). Competing carnivorous plants capture more flies than the *Dionaea*. Below: A close-up of the *Dionaea*.

two weeks showed no new captures were made when the vents were closed. Trap reopenings were recorded instead of closures so capture rates were computed as reopenings/day.

Ultraviolet (UV) experiments

Measurements of UV reflection/absorption and fluorescence were made using an ultraviolet lamp (Raytech Versalume UV-lamp with two glass filters for 254nm and 366nm) that emits a spectral curve from approx. 230-420nm with two maxima at 254nm and 366nm. The emission spectrum of the lamp has a visible shoulder from 380-420nm, which appears as dark-blue light. The invisible long-waved UV radiation (around 366nm) is either reflected (impinging light spectrum = reflected spectrum) or absorbed (no reflection, the surface remains dark) or it produces (with some excep-

Figure 3: Garden Pond Habitat. Above: *Dionaea* (white box) similar to that found in the wild growing at the base of *Sarracenia* in the pot to the left rear. The pond is a barrier to prey that cannot fly. Below: Close-up of the *Dionaea*.

tions, i.e. Rhodamine = red fluorescence at 580nm) a bright blue to cyan fluorescence between 420-500nm (The impinging lamp spectrum becomes transferred into a bright visible light, shifted to a longer wavelength by an optical active compound inside or upon the plant tissue). To evaluate such UV studies requires some experience in order to differentiate between UV reflection and fluorescence and to avoid confusion and mistakes; in addition, safety glasses should be used. *Dionaea* and the peristome of *Nepenthes talangensis* × *truncata* were observed for both UV reflection/absorption and fluorescence. As reference for active fluorescence we used writing paper containing optical

brightener (Exact composition of the brightener was not labeled on the packaging, but usual for this application is a stilbene derivate mixed with SiO_2 as white filler (also called white body)) that shines super white[1] under UV-radiation.

Review, new results, and discussion

Prey capture in the Natural Habitat

The first person to make an effort to actually see what *Dionaea* captures in its native habitat was Charles Darwin (Darwin 1875, p 312-313). He wrote to Dr. Canby who "visited the native site of the plant, early in the season, before the leaves had grown to their full size, and sent... [Darwin] fourteen leaves, containing naturally captured insects. Four of these had caught rather small insects, viz. three of them ants, and the fourth a rather small fly, but the other ten had all caught large insects, namely, five elaters, two chrysomeles, a curculio, a thick and broad spider, and a scolopendra. Out of these ten insects, no less than eight were beetles, and out of the whole fourteen there was only one, viz. a dipterous insect, which could readily take flight." This amounts to 1/14 flies, 3/14 ants, 1/14 spiders, 8/14 beetles, and 1/14 centipedes. Darwin notes that "only one of the 14 insects could readily take flight but that Drosera ... lives chiefly on insects which are good flyers, especially Diptera, caught by the aid of its viscid secretion". Even at this early date there was strong evidence that *Dionaea* in its native habitat captured a diverse array of insects, most of which could not readily take flight. Darwin also stated in a footnote that Mrs. Treats' cultivated-plants in New Jersey "chiefly caught Diptera". *Dionaea* in the garden habitat of Mrs. Treats captured flies while those in the wild or native habitat captured an array of insects most of which could not readily take flight.

The next observation of prey captured by *Dionaea* in its native habitat was by Frank Morton Jones (1923). Like Darwin, Jones observed a diverse array of insects captured. Jones sample of 50 prey animals, much larger than Darwin's 14, shows 82% to be incapable of agile flight, close to Darwin's observation of 93%. A diverse group of beetles was captured just as Darwin observed but a much smaller portion were beetles... 18% as opposed to Darwin's 57%.

Two subsequent field studies have also been done on larger samples of prey captured by *Dionaea* in its native-habitat. One based on captures by 152 traps (Lichtner & Williams 1977) and a second based on captures by 337 traps (Hutchens & Luken 2009, 2015). A comparison of the results of all four studies of captures by *Dionaea* in its native habitat is listed in Table 1. The percentage of flies captured in the field varies from 1% (Hutchens & Luken 2009) and 18% (Jones 1923). The average for all prey captured in the four studies is about 7% Diptera. The differences may be due to differences in the amount of carrion and fecal matter in the vicinity of the plants and thus the ability of the habitat to generate flies.

The predominant prey animals captured in the natural habitat are spiders, ants, and beetles. Spiders constitute approximately one third of the prey captured (18% Jones 1923, 30% Lichtner & Williams 1977, 31% Hutchens & Luken 2009, 2015). They have been reported resting in open traps (Lichtner & Williams 1977) so it seems likely that they walk into the traps and take cover between the lobes. Ants also constitute about one third of the prey (20% Jones 1923, 33% Lichtner & Williams 1977, 26% Hutchens & Luken 2009). The ants must walk into the traps. Jones (1923) reports them being attracted

[1] "Super White" sometimes also "superwhite" is an established term used for paper and laundry treated with an optical brightener that generates a super white appearance due to a blue hue fluorescence usually at approximately 420nm under sunlight (or any light containing UV). Such laundry detergents have been promoted for washing "whiter than white" or super white. The term emerged in the 1960-70s and is still used in optical brightener-related chemistry as well as bright white paper and laundry detergent promotion (Messier *et al.* 2005; https://en.alfakimya.com/textile-optical-brighteners).

Table 1. Percentage of various orders of insects captured by *Dionaea* in its natural habitat in the Carolinas.

	Darwin	Jones	Lichtner &Williams	Hutchens & Luken 2009	Hutchens & Luken 2015
Citation	1875	1923	1977	Native	Introduced
Arachnid (class)	7.1	18	29.6	31	22.5
Hymenoptera	21.4	20	32.9	28.3	42.8
Coleoptera	57.1	18	11.8	12.3	9.8
Orthoptera*	0	14	14.5	2.5	4.1
Diptera	7.1	18	4.6	1.5	3.5
Other	7.1	12	6.6	24.4	17.4
Total Captures	14	50	152	337**	227**

*Orthoptera used to include Blattodea. The earlier studies by Jones (1923) and Lichtner & Williams (1977) include cockroaches in Orthoptera.
**Capture numbers provided by John J. Hutchens of Coastal Carolina University.

to the "alluring glands" along the edge of the trap. Beetles are the next most common prey captured (18% Jones 1923, 12% Lichtner & Williams 1977, 12% Hutchens & Luken 2009, 2015). Various Orthoptera are also captured in significant numbers (14% Jones 1923, 14.5% Lichtner & Williams 1977, 2.4% Hutchens & Luken 2009). The remaining prey are diverse and captured in small numbers. Both Jones (1923) and Lichtner and Williams (1977) used the older definition of Orthoptera that included Blattodea so their capture numbers for Orthoptera are inflated by a few cockroaches.

Hutchens and Luken (2015) also identified the prey captured by *Dionaea* that were introduced into habitat in South Carolina near already existing established populations. The captures made by these introduced plants were very similar to those made by established plants native to the habitat (Table 1).

It is clear from all the studies done in the natural habitat that flies are of minor importance as a prey animal and that spiders, ants, and beetles are the bulk of the prey captured. Nearly all of the prey animals captured in the natural habitat either are incapable of flight or are clumsy fliers.

Prey capture in the Garden and Greenhouse Habitats

For comparison we made limited observations of prey captured in the greenhouse habitat and garden habitat (Table 2). In both of these habitats flies are a major component of the prey with the garden habitat showing a lot more diversity.

Captures in the Garden Pond

Of the 50 active traps observed in the Garden Pond over 80 days there were 63 (65 prey) captures 37 or 59% Diptera. Thirty seven percent of the total captures were flies. Only two spiders and five ants (four winged) were captured. No Orthoptera and only 2 (3.2%) Blattodea (cockroaches) were captured. The Garden Pond is a 20-year-old stand of *Dionaea* in a large pot with other carnivorous plants that effectively forms an island in a small garden pond. Because of this location flying insects had more access to the traps than those incapable of flight. It is likely that a garden with better access by flightless prey could see larger numbers of ants, spiders and other such flightless animals captured.

Table 2. Orders of insects captured by *Dionaea* in a garden habitat and a greenhouse habitat.

Habitat GP	Habitat GH	Order	GP= Garden Pond captures, GH= Greenhouse captures
39	19	Diptera	GP (24 flies, 6 mosquitos*, 4 midges, 4 hoverflies, 1 fruit fly), GH (19 flies)
12	1	Hymenoptera	GP (1 ant worker, 4 winged ants, 5 wasps, 1 bee, 1 unknown hymenoptera); GH (1 bee)
3	1	Hemiptera	GP (2 cicadas, 1 green shield bug); GH (1 green shield bug)
2		Blattodea	GP (2 cockroaches)
2		Arachnida (class)	GP (2 spiders)
2		Neuroptera	GP (2 adult antlions)
1		Coleoptera	GP (1 beetle)
1		Gastropoda (class)	GP (1 snail)
1		Unknown	GP (1 larva**)
3		Unknown	GP (3 unidentifiable fragments)
66	21	Total	

*Two times two mating mosquitos were captured together -- 8 mosquitos in 6 captures.
**The larva was likely brought into the trap by an ant that escaped.

Captures in the Greenhouse

Of the 33 active traps in the greenhouse observed over 36 days there were 21 captures over 90% of which were flies. One true bug and a bee were also captured. The strong impression, held by many, that the main prey of *Dionaea* is flies is, no doubt, strengthened by similar observations by those of us who grow this plant in our greenhouses.

The primary objective of Darwin (1875), Jones (1923), and Hutchens and Luken (2009) was to test Darwin's hypothesis that the structure and closure mechanism of *Dionaea* traps allow smaller prey to escape so an emphasis was placed on the size of the prey captured rather than its type. The analysis of the prey captured by *Dionaea* in its native habitat done by Lichtner and Williams (1976) and Williams (1980) emphasized the type of prey captured. Looking at the data this way leads to some important conclusions.

1. *Dionaea* captures a wide array of prey species.
   The species captured are primarily determined by the species available in the habitat. There does not seem to be a specific syndrome[2] that defines the captures such as flying insects, prey attracted to nectar, or prey that might be lured by a sex attractant. The capture mecha-

[2] In flowers, a pollination syndrome is a suite of flower characteristics that result either in the attraction of specific animal pollen vectors such as bees, hummingbirds, butterflies, or flies, often to the exclusion of other vectors, or characters that allow physical vectors such as wind to be more effective. An example is the fly pollination syndrome, which has a smell that attracts flies and often a trap that temporarily holds them (i.e. *Amorphophallus* species) while they pollinate the flower. Some flowers are generalists and have many pollinators (Faegri & van der Pijl 1979).

nism of *Dionaea* is not specific for flies. It is likely that most of the prey captured in its native habitat walks up the leaf petiole into the trap. The common name "flytrap" is misleading. In the various studies only between 1.5% (Hutchens & Luken 2009, 2015) and 18% (Jones 1923) of the captured prey are Diptera while the rest are either non-fliers or clumsy fliers. The presence or absence of animal carcasses or droppings nearby probably causes the fly populations to fluctuate greatly but, in general, where *Dionaea* is native, relatively few flies are captured. By contrast in the human related garden habitat and greenhouse habitat many flies are captured.

2. *Dionaea* is a generalist in terms of the prey captured.
   This brings into question suggestions of elaborate systems analogous with pollinator attractants in flowers such as alluring glands that act as nectaries (Jones 1923), UV patterns (Joel *et al*. 1985), and attractive scents (Kreuzwieser *et al*. 2014). The descriptions of captures by the "flytrap" and many of the proposed attractants may have been influenced by observations of *Dionaea* capturing flies in its greenhouse and garden habitats and by analogies with fly pollinated flowers as opposed to looking at the plant in its native habitat where the evolutionary pressures that led to development of its capture mechanism exist. Of the proposed methods of attraction only Jones' (1923) observation that ants are attracted to "alluring glands" (Fig. 4) is documented.

While studying plants in the greenhouse habitat, a fly was observed moving to various points on a trap working its mouthparts over the area with alluring glands in the same way that the small ants described by Jones (1923) did (Fig. 4). This fly may have been attracted to the same thing that Jones' ants were but the attraction does not seem to act over longer distances since flies enter traps only infrequently. A BBC ONE video (2009) shows a fly lapping abundant nectar from the area of the alluring glands of a *Dionaea* trap. Our trap was dry (Figs. 4 & 5) and Jones (1923) does not mention abundant secretion in the area where the ants he observed were attracted. In our experience unstimulated traps that have not been wet by an outside source are always dry unlike those in the WildFilmHistory (1974) and the BBC ONE video (2009).

Prey capture rates in various habitats

If *Dionaea* plants are observed in almost any setting, the majority of the traps are open, often untouched by prey. This suggests that prey is captured infrequently. Captures and leaf closures without capture by 201 functional *Dionaea* traps in the field were measured during 24 hours in its native habitat by Lichtner and Williams (published in Williams 1980, see Table 3). Only six prey were captured by the ten traps that closed during this period. At this rate about 0.9 prey captures would occur per month so a plant with 6 functional traps would capture an average of approximately 5.5 prey a month. Capture rates may vary from day to day and according to conditions, but unless a large source of prey becomes available or adverse weather occurs, we would expect this measurement is in the normal range. This single observation should be supplemented by many more field measurements of capture rates in order to be considered representative, but a low rate like this is what would be expected if most the traps in the field are open.

An example of weather conditions affecting prey captures occurred on a day when it rained continuously (Table 3). No captures were made. Interestingly 15 traps of 202 that were capable of closing were closed without capturing prey as opposed to the 4 that closed on a day with no rain. Raindrops striking the trigger hairs could have closed these. Those of us who have watered *Dionaea* plants in a greenhouse probably agree that Darwin's observation that "Drops of water or

Figure 4: Close-up of a *Dionaea* trap. A= Alluring glands (green). S= Smooth area where the trap seals when digesting prey. D= Digestive glands that secrete fluid and digestive enzymes after prey is captured. T= Trigger hair, the sensory organ that triggers closure of the trap. The fly has its mouthparts on the alluring glands that are dry.

a thin broken stream, falling from a height on the filaments did not cause the blades to close" is usually accurate, although we have seen traps close on occasion when we watered them. However, his statement that "no doubt as in the case of *Drosera*, the plant is indifferent to the heaviest shower of rain" seems unlikely since a day of intermittently heavy showers resulted in 15 closures of 202 traps exposed to rain but probably not to prey animals while only 4 were closed on a clear day with exposure to prey animals.

Figure 5: A single observation of a fly landing on a large *Dionaea* trap in the greenhouse. It moved about the periphery of the leaf working its mouthparts on the area where the alluring glands are located in a manner similar to the small ants observed by Jones (1923). The trap is dry with no obvious nectar visible. This fly landed on the petiole and walked into the trap.

Captures in the Greenhouse and Garden Habitats

The capture rates computed for the Greenhouse and Garden Pond Habitats are listed in Table 4. Though lower than capture rates in the natural habitat they were of the same magnitude. The Greenhouse capture rates are lowest, about 34% of that of *Dionaea* in its natural habitat. This is likely partly because access to the greenhouse by insects was limited during periods of cooler temperatures when the greenhouse vents were closed. During two weeks of observations of greenhouse *Dionaea* after the vents were closed no captures occurred so when the vents were closed the capture rate was zero. The few flies that were able to enter when the vents were closed were captured by large *Nepenthes*, *Sarracenia*, and *Drosera*. These other carnivorous plants located near the *Dionaea* reduced the prey available to the Greenhouse *Dionaea* (Fig. 2) at all times and contributed to the low capture

Table 3. Prey capture in 24 hrs. by *Dionaea* in its native habitat during periods of heavy rain and no rain.*

Weather	Rain	No Rain
Total Traps	244	224
Traps that could close**	202	201
Captures	0	6
Closures without capture	15	4

*The study was done in late June near Supply, NC.
**Measured by triggering open traps after observations.

Table 4. A comparison of capture rates in different habitats.

Habitat	Captures/leaf/month
Garden Pond	0.55
Greenhouse	0.30
Natural	0.89

rate. The Garden Pond *Dionaea* population captured prey at about 61% of the rate of *Dionaea* in its natural habitat. It is likely that the pond water acted as a barrier to prey incapable of flight with only reduced access over the lily pads on the water (see Fig. 3) thus reducing the number of captures. Unfortunately it is impossible to make firm conclusions based on single samples of the capture rate in each location. An additional problem in comparing the capture in the Greenhouse with those in the Garden Pond arises because the plant forms of *Dionaea* are different. In the greenhouse, the locally-named "Predator" and "Destroyer" plants had large traps ranging up to 5 cm in size, while the plant in the Garden Pond was the common form of *Dionaea muscipula* similar to those found in the wild. More extensive sampling under better-controlled conditions needs to be done. In addition, in the future, controlled experiments on the comparative attractiveness of various carnivorous plants to different types of prey should be made. Also other carnivorous plants in the greenhouse were in competition with *Dionaea* for the flies. The competing *Nepenthes* species attracted prey with abundant nectar drops and *Drosera fragrans* and *Drosera* aff. *indica* "Africa" have a noticeable fragrance produced by their leaves, both of these attractants are lacking in the *Dionaea* we observed.

Alluring prey to traps

Numerous flowers have various mechanisms that attract pollinators (Faegri & van der Pijl 1979). There is strong evidence that some carnivorous plants have similar mechanisms that attract prey (Jürgens *et al.* 2009; Moran & Clark 2010). Such attraction or alluring mechanisms have been proposed to exist in *Dionaea*, but much of the information is from secondary sources without citations or from selected poses from educational videos, such as the BBC ONE video (2009). Many statements about such mechanisms have been made with little evidence to support them. Those that seem reasonable are often accepted as accurate and get widely repeated in popular literature and educational material on *Dionaea*. Some of the alluring mechanisms may even exist, but far more rigorous observation and experimentation should occur before we accept descriptions of them as accurate.

The following alluring mechanisms have been proposed to exist in *Dionaea*:

1. Alluring glands, a name assigned to glands structurally identical to digestive glands, were named by Jones (1923). They are located just beyond the smooth area around the edge of the trap inside the "cilia" along its rim (Fig. 4). These are not pigmented like most digestive glands and are slightly smaller in size. Jones (1923) reported that in its native-habitat small ants were attracted to these glands and that they move their mouthparts over them as if taking

up nectar. He also reported that a large wasp exhibited the same behavior. There are numerous undocumented secondary sources that state that nectar is secreted by these glands and possibly a scent. There are also impressive educational videos of flies attracted to these glands. We have never seen secretion from these glands and other than Jones' paper, there is little scientific work to indicate that they act as nectaries. When we observed the glands under the microscope, no secretion was visible. Except when wet by external sources, such as misting systems, the glands in unstimulated traps were always dry. The dry traps of *Dionaea* are probably an advantage since it makes most captures in hot and sunny weather. By comparison, in such weather the nectar secreted by *Nepenthes* pitchers becomes very viscous, finally crystallizing (Fig. 6). In *Dionaea* such incrustations would prevent smooth sealing when the traps close and complicate digestion by drying out the trap contents.

2. Alluring scents have been proposed. Jürgens *et al.* (2009) studied volatiles emitted from the traps of a number of carnivorous plants. In three species of *Sarracenia*, compounds typically found in flowers or fruits were found, suggesting that together with other features such as color and nectar production, the emitted volatiles may allow the traps to act as flower or fruit mimics. However, they found that the leaves of *S. purpurea*, *Dionaea muscipula*, and *Drosera binata* emitted much weaker scents with lower numbers of components, consisting mainly of volatiles typically emitted from green leaves. This does not support the notion of a scent acting as a part of a suite of attractants in *Dionaea*.

   In a more recent study, Kreuzwieser *et al.* (2014) found that *Dionaea* releases volatile organic compounds including terpenes, benzenoids, and aliphatics that attract fruit flies (*Drosophila melanogaster*). They concluded that *Dionaea* attracts insects using food smell mimicry "since the scent released has strong similarity to the bouquet of fruits and plant flowers". This does not sound like the "weaker scents with lower numbers of components, consisting mainly of volatiles typically emitted from green leaves" described by Jürgens *et al.* (2009).

   In addition, fruit flies are not typical prey of *Dionaea*. Only one fruit fly was captured during our observations. Would spiders, grasshoppers, and many of the range of prey in *Dionaea* traps be attracted by floral or fruity scents? This seems unlikely.

3. Red coloration mimicking meat such as fly pollinated flowers has been said to attract flies. Carrion flowers actually do attract fly pollinators in this way and some, such as skunk cabbage (*Symplocarpus foetidus*) and *Aristolochia* have a red color resembling carrion in addition to the appropriate scent (Faegri & van der Pijl 1979). Red coloration of pitcher plants has been reported to attract prey (Schaefer & Ruxton 2008), but more recent experiments show that nectar rather than color is the attractant (Bennett & Ellison 2009). There is evidence that the red coloration of *Drosera* is not involved in prey attraction (Foot *et al.* 2014; Schaefer & Ruxton 2008). In *Dionaea* there is no evidence that the red coloration of the traps are involved in prey capture. The presence of both red and green traps in the wild and the lack of red color's involvement in other carnivorous plants makes it unlikely that *Dionaea* traps red coloration plays an important role in attracting prey. *Dionaea* traps lack the potent carrion smell or fecal smell often present in fly pollinated flowers and is not likely to be a carrion mimic.

4. Ultraviolet (UV) patterns similar to those that attract flower pollinators have been described by Joel *et al.* (1985). Included in their account is a photograph and description of the UV pattern on a *Dionaea* trap. It shows the zone of the trap with the alluring glands absorbs ultraviolet light and the zone with digestive glands reflects it. A pattern would therefore be visible to insects with UV vision, such as bees. They state that this is evidence in favor of Jones'

Figure 6: A = The trap of *Nepenthes bicalcarata* with attracting nectar drops on the outside. B = During the hot season the secreted nectar becomes very viscous and forms incrustations of crystallizing sugar. C = The open trap of *Dionaea* is always dry, smooth and shiny.

(1923) idea of a baited system over Lichtner and Williams (1977) proposal that traps are not baited and prey capture is non-specific. Our observations with a 230-420nm UV-lamp with peaks at 254nm and 366nm show a pattern that results from a difference in reflection of UV by the inner digestive zone and absorption on the upper margin of the trap zone with alluring glands (Figs. 4 & 7). While this pattern agrees with the data of Joel *et al.* (1985), compared with the patterns of flowers that are known to attract insects, this pattern lacks contrast and is unspectacular. In addition, we found no visible fluorescence from *Dionaea* traps similar to that observed from traps of other carnivorous plants such as peristomes of *Nepenthes* and

Figure 7: A = *Dionaea* under UV showing no luminescence. B = *Dionaea* under UV with a piece of super white paper (containing fluorescent optical brightener) as reference. The very bright luminescence of the super white paper as reference proves that enough UV-light is given to excite fluorescence when present. C = The dark blue light (approx. 380-420nm) that is emitted by the UV-lamp is reflected from the digestive zone together with invisible UV (maximum at 366nm). The margin with alluring glands shows very low to no reflection. This confirms a UV-pattern as shown by Joel *et al.* (1985). But it is not very spectacular compared with the patterns of attractive flowers. D = The peristome of this *Nepenthes talangensis* × *truncata* shows a bright and clear fluorescence under UV. The UV from the lamp (366nm) is transferred into bright visible light, which is shifted to the longer wavelength at approx. 490nm (blue-cyan).

Sarracenia (Fig. 7, Kurup *et al.* 2013; Hartmeyer *et al.* 2013). This lack of active fluorescence and the rather inconspicuous pattern due to reflection and absorption suggests that UV is not involved in attracting prey.

Does the size of prey matter?

Darwin (1875) noticed that when an insect enters a *Dionaea* trap and touches a trigger hair twice or two trigger hairs once, the trap rapidly closes such that the marginal projections ("cilia") on each of the opposing lobes bar the escape of larger prey. Struggles against the trigger hairs cause the trap to completely close, sealing the lobes along the smooth areas on the surface of the trap near its rim.

Smaller insects should be able to escape during the period that the trap is partially closed. Darwin said one of his sons actually observed this. He thought allowing the small prey to escape would save the plant a great deal of energy expenditure on a capture that was of little value to the plant. Darwin's letters to Canby and his request for captured insects were explicitly done to test this hypothesis (Jones 1923). Of the 14 insects captured, 3 were small and 11 were large enough to have been retained by the marginal projections blocking their way. He considered this adequate evidence for his model despite 21% of the captures in the small sample being of a size that should have escaped. However, Jones (1923) did not accept the model on this basis. Jones looked at captures by 50 traps and found of the 50 captures only one was less than 5 mm in length and only 7 were less than 6 mm. Ten were 10 mm or more in length with a maximum of 30 mm. Jones (1923) concludes that in the mature traps he studied, prey less than 1/4 in (= 6.35 mm) escape while others are captured. Sixteen percent of his larger sample was small enough to have escaped compared to 21% of Darwin's. Jones accepted Darwin's model presuming that most of the smaller prey had escaped.

A more elaborate experiment was done by Hutchens and Luken (2009) with a much larger sample of 337 captured prey. They compared leaf size with capture size in large, medium, and small sized traps. With the exception of a few infrequently captured large prey animals captured by large traps, all three sizes of traps captured the same range of sizes of animals. Large, medium, and small traps all tend to catch relatively small prey. Larger traps can let small prey escape, but it does not appear that they are very good at the task of primarily collecting large prey. Hutchens and Luken's data does show that the larger size traps collect larger prey on average due to a few very large captures, so a larger trap is better able to capture larger animals than the smaller traps. However, it is not clear if this advantage is due to letting small ones escape or just being able to hold onto a larger prey item compared to a smaller trap. They conclude that "Carnivory in *Dionaea* is not size selective" and that "Large insects were not preferentially captured". Perhaps Darwin's elegant idea about the efficiency of letting the "small ones get away" may occur but may not be the general case.

How is prey captured by *Dionaea* traps?

The answer depends on where the observation is made. A *Dionaea* plant in a greenhouse will likely have a fly land directly on its leaf. The fly in Figure 4 landed on the petiole of the trap and walked into it. The prey then moves around in the trap, possibly visiting the area of the alluring glands. If it brushes the trigger hairs twice the trap will snap shut. Its struggles will lead to trap narrowing and the digestion of the prey. After digestion, the trap will reopen and only the exoskeleton of the fly will remain. This scenario is well illustrated by Attenborough (1995) in a video that shows a beetle walking up a trap growing wild in the Carolinas into the trap that is then triggered and closes and digests the insect as described above.

A *Dionaea* plant growing wild in the sandy soils of the coastal regions of the Carolinas in the open sun with pine trees nearby is likely to have an ant or beetle walk up its petiole into the trap or to have a spider select it as a hiding place. If any of these animals stimulates two trigger hairs (or one hair twice) the trap will close on it, the struggle of the prey will cause narrowing, and the prey will be digested except for the exoskeleton which will remain after the leaf opens.

It is possible that ants are lured into the trap (Jones 1923), or that they just blunder in, as the beetles certainly must. The spiders appear to be attracted to the traps as a hiding place (Williams 1980). Other than Jones' observation, there is no evidence of alluring prey into *Dionaea* traps except in the popular and educational literature and videos. There may be lures of some type but convincing evidence is lacking.

Both in the greenhouse and the wild, the trap will remain partly open for a while with the way out barred by the marginal spikes (cilia) along the edge of the leaf. During this period small prey can escape from large traps but according to Hutchens and Luken (2009), statistically most do not.

The Venus flytrap is the first thought to come to most people's mind when someone says "carnivorous plant". It is unfortunate that we do not have better information on the interaction with the prey captured by the plant in its native-habitat. Descriptions and even careful experiments based on this plant's behavior in greenhouses and gardens far away from its native habitat have led to a great deal of lore about its behavior right down to the notion that it is primarily a fly-catching plant. Once established, this lore takes on a life of its own. Not all of it is necessarily false, but far more rigorous observations with reference to the plant in its native habitat needs to be done before we accept it as fact. We have to ask, should *Dionaea muscipula* even be called a flytrap?

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Nepenthes robcantleyi: A natural hybrid

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Introduction

This paper is a follow-up to the protologue of the newly described *Nepenthes nebularum* Mansell & Suarez (2016), and presents details leading to the inevitable conclusion that *N. robcantleyi* (Cheek 2011) is not a species but a natural hybrid originating from a combination of *N. truncata* Macf (1911) and *N. nebularum*.

In April 2013, author Geoff Mansell, corresponded with the then Acting Keeper of the Kew Gardens Herbarium, Dr. David Simpson to obtain clarification of the description of *N. robcantleyi* and a copy of the photos kept at K and PNH, which represent the wild parent and a paratype, that were used for comparison in the paper. Dr. Martin Cheek, Senior Research Leader at Kew Gardens and the author of the *N. robcantleyi* description, responded in kind and also commented on the topic of *N. robcantleyi* being a natural hybrid. Basically he said that to qualify as the missing *N. robcantleyi* parent a new species should at least have fringed wings, a squatter pitcher than truncata, a well developed lid dome with nectar glands concentrated there, long widely spaced peristome ridges and teeth, and partial-peduncles with bracts on the inflorescence.

Since this communication, *N. nebularum* has been described and in the above correspondence the specific traits proposed are attributed solely to a new species. However most of these are *N. truncata* and/or *N. nebularum* characteristics. Also, from what the authors have established, the characteristics that Cheek assigned solely to *N. robcantleyi* are actually intermingled ones from the other two species mentioned, as discussed below, with the only conflicting factor being the partial peduncle bracts that, to the best of our knowledge, have only been displayed on the type specimen of *N. robcantleyi*.

Notes on the discovery and description of *N. robcantleyi*

Nepenthes robcantleyi was described from cultivated material and from photos of the putative female parent as detailed in the following excerpt from Cheek (2011) [A link to the photo can be found at http://pitcherplants.proboards.com/thread/10684/black-truncata-new-species?page=12]:

> "In January 1997, Robert Cantley was in Mindanao, Philippines, seeking to collect seeds of *Nepenthes truncata* for his plant nursery 'Borneo Exotics'. Having obtained permission to collect in a logging concession, and accompanied by the head of security for the logging corporation to whom the concession had been granted, he observed a large number of plants believed to be *N. truncata*. These plants had set seed but their fruit was as yet all quite immature and bore no viable seed. At the same location he also discovered two morphologically atypical plants, one of which was nearing the end of it's fruiting phase, with one seed head from which nearly all seed had already dispersed. Robert collected the limited amount of seeds remaining and succeeded in raising nine individuals, which at maturity were found to match the photographs that he had taken of their wild parent. Since their pitchers were much

darker than typical *N. truncata*, some with a black peristome, they have been exhibited at flower shows worldwide as 'The black *N. truncata*'. Whilst morphologically uniform, these seedlings show variation in peristome colour reflected in the cultivar names given to three of the individuals, respectively 'King of Spades', 'King of Hearts' and 'Queen of Hearts'".

In reference to the above excerpt, Cantley said the putative female parent of *N. robcantleyi* was growing with a large number of plants that were believed to be *N. truncata*. Borneo Exotics later offered seedlings of these *N. truncata* plants for sale described as *N. truncata* "highland from Mt. Pasian, Mindanao", in 2002. Another point stated (Cheek 2011) is that Cantley succeeded in raising nine individuals from the original wild-collected seed which at maturity were found to match the photographs of their wild parent. However, in fact, there were eleven individuals and Cantley raised only six of these (Paroubek, pers. comm.). Cantley explained on a public forum that the other seedlings (five) were accidentally sent to other nurseries through staff mistakes when sending out seedlings of the *N. truncata* - Mt. Pasian, where one ended up in the collection of Shinya Yamada of Japan, and four to Tony Paroubek of Par-O-Bek Orchids in the United States.

Nepenthes robcantleyi's similarities with *N. truncata*

In the introduction to the description of *N. robcantleyi*, it is mentioned that the original seedlings proved to be "morphologically uniform", only showing "variation in peristome colour". However, it is now known that the extant siblings from the original batch exhibit degrees of variations that do not fit the distinguishing characters stated for *N. robcantleyi*. Perhaps the most instantly notable here, concerns the lid dome which was stated to be a diagnostic character for his species. This feature is actually absent in the cultivated plants mentioned previously, Yamada's plant and also in the cultivated plant unofficially named "Un-named 3" which was presented by Cantley on a forum as a diagnostic tool for *N. robcantleyi* and can be viewed at the following web site: http://pitcherplants.proboards.com/thread/10684/black-truncata-new-species?page=14. Moreover, the lid boss is also absent on the seed parent; although a domed lid is evident on the photo showing it being held by a

Figure 1: The plant grown by Shinya Yamada (left) and its male flower (right). Photos by Shinya Yamada.

Figure 2: Partial-peduncle bract remnants of female *N. truncata* flower. Photo by Exotica Plants.

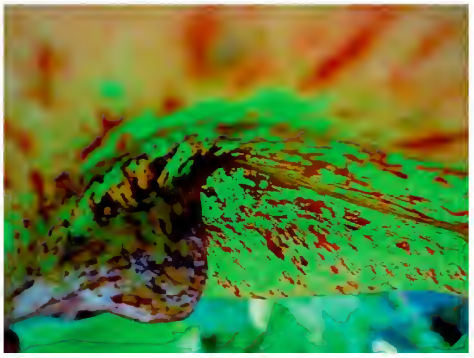

Figure 3: Lid dome and gland concentration of *N. truncata*. Photo by Exotica Plants.

Filipino, the other known photo in existence, perhaps taken at a later date, shows the lid base at a much straightened out configuration, but becoming decidedly convex towards the middle portion; a closer examination reveals that the median keel is broken, perhaps an artifact of human or animal induced damage. The flaring peristome said to also be a distinguishing feature of *N. robcantleyi*, is not observed on Yamada's specimen, and so we cannot use this as means to delimit *N. robcantleyi* from *N. truncata* (Fig. 1). The presence of partial peduncle bracts in female inflorescences is also mentioned in the protologue as a character that separates it from *N. truncata*. But further research and observation by the authors from plants in anthesis has also shown that some plants of *N. truncata* do display partial-peduncle bracts, albeit rudimentary (Fig. 2). In the description (Cheek 2011), it was also said that these same bracts are absent on male inflorescences, and yet these are clearly developed in Yamada's plant, which is male (Fig. 1). The characterization of the lid gland concentration on the lid dome and the basal appendage, is actually a characteristic observed in *N. truncata* (Fig. 3). Lastly, the dimensions achieved by both the seed parent and its cultivated progenies match those reached by *N. truncata*.

Shared traits of *N. robcantleyi* with *N. nebularum*

Nepenthes robcantleyi appears to have more in common with the recently described *N. nebularum* than it has with *N. truncata*. For one, the flaring of the peristomes seen in a number of *N. robcantleyi* plants is actually commonly observed in *N. nebularum*. The leaf tip acumen in *N. robcantleyi* is also present in *N. truncata* but much abbreviated, but this is also well-developed in *N. nebularum*. The development of peristome ribs in *N. robcantleyi* is also very similar to *N. nebularum*, as are the peristome teeth, although the degree of development is comparatively more pronounced in the latter taxon, which can have teeth extended for up to 5 mm in length. Additionally, pitcher wings are present in both *N. nebularum* and *N. robcantleyi* even up to maturity, and both share similar dendritic indumentum, however these are expressed to a more reduced degree in the latter. One feature that clearly sets *N. nebularum* apart from *N. robcantleyi* is seen in the plants' dimensions, with *N. robcantleyi* attaining greater sizes than *N. nebularum*.

The plant grown by Yamada shares some similarities to *N. robcantleyi* but does not match the original description. To be specific, it is visually distinguishable, by its smaller size, lack of lid dome, and bracts that are present on the partial-peduncles of the male flower.

Inconsistent morphological traits of *N. robcantleyi*

In light of morphological similarities of *N. robcantleyi* to both *N. truncata* and *N. nebularum*, the question that begs an answer is "what then are the distinguishing traits of *N. robcantleyi*?" The problem here is that the description was based heavily on the unofficial cultivar "Queen of Hearts", which served as the holotype. An inspection of the protologue of this taxon tells us that the "Additional specimens examined (paratypes)", are Cantley's "photographic record" and Cheek 15877, which incidentally, also happens to be the holotype. Other variants of *N. robcantleyi* with the unofficial cultivar names, "King of Spades" and "King of Hearts" differ quite noticeably from the type, although in the description of *N. robcantleyi* (Cheek 2011), it was stated that they were morphologically uniform, including pitcher color. It should be noted that although pitcher color is not usually used as a strong distinguishing characteristic, it is quite relevant when compared to *N. nebularum*.

Figure 4: The two seedlings grown by Tony Paroubek that had deformed growth and subsequently died. F2, F3 hybrids? Photos by Tony Paroubek.

With regards to the floral bracts, it has never been detailed that the flower spike of the putative female parent of *N. robcantleyi* displayed these. However, we believe that its presence should have been examined as well as the nine *N. robcantleyi* plants themselves. To date, Yamada from Japan has a male plant of *N. robcantleyi* from the original nine which displays these floral bracts. At the time of writing this article, the only male plant of *N. robcantleyi*, that we are aware, Borneo Exotics has flowered, is the unofficial cultivar "King of Spades" which has no floral bracts. With the limited number of plants of *N. robcantleyi* that were produced and available for examination and the contrasting production of these bracts, we believe that this characteristic is atypical and is an exception most likely attributed to the hybrid origin of *N. robcantleyi* and not a distinguishing factor. Indeed, the supposed diagnostic traits of this taxon overlaps both those of *N. truncata* and *N. nebularum*. It should be noted that hybridization from several parents (complex) can produce surprising results, as will be discussed later in the paper.

Of the four seedlings that Paroubek raised, none are known to have survived. However, he explained (pers. comm.) that two died before maturity and never grew properly, always had deformed leaves and stunted growth, and the other two large plants were stolen before they reached maturity. The description that he gave of the deformed growth of two of the plants was likely an indication of F2 or more hybridization, as has been observed at Exotica Plants over many years of hybridizing *Nepenthes*. It can also be seen in the photographs supplied by Paroubek (Fig. 4) that the deformed growing plants were more like immature *N. truncata* than *N. robcantleyi* in their pitcher morphology. With the publishing of *N. nebularum* there are no doubts that *N. robcantleyi* characters are a mixture of both *N. truncata* and *N. nebularum*. It seems very likely that *N. robcantleyi* occurred from hybrid events between these two species and further introgression. This introgression is apparently still occurring as is suggested by photos (Fig. 5) from habitat on Mindanao, Philippines.

Figure 5: Introgression in *N. nebularum* in habitat. Photos by Mark Rouse.

A further comment (Cheek 2011) suggests possible hybrid origin of *N. robcantleyi* as follows in this excerpt: "... he (Cantley) observed a large number of plants believed to be *N. truncata*. These plants had set seed but their fruit was as yet all quite immature and bore no viable seed. At the same location he also discovered two morphologically atypical plants, one of which was nearing the end of its fruiting phase, with one seed head from which nearly all seed had already dispersed." Although this statement is alluding to the difference in flowering times of *N. truncata* and *N. robcantleyi*, it should be noted that Cantley observed only one fruiting plant which may or may not have flowered typically. In our observations, flowering male plants of *N. truncata* typically begin flowering at least one month before the female plants, may have multiple flower spikes, and continue to flower for several months after the female plants have been pollinated. Therefore in the scenario detailed in Cheek's paper, hybridization was very likely and probable due to the abundance of *N. truncata* plants and no observation of any atypical mature male plants.

Magnified evidence of *N. nebularum* in *N. robcantleyi* second generation progeny

Further evidence that *N. nebularum* was one of the parents of *N. robcantleyi* can be seen in the seedlings that were produced by Borneo Exotics nursery (Cheek 2011), by crossing two differing variants of *N. robcantleyi*. The diluted characteristics of *N. nebularum* seen in *N. robcantleyi* have now been amplified in the crossing, which we believe is a further hybridizing of *N. robcantleyi*. It has been observed that this progeny vary a great deal and interestingly, there have been noted deformities in leaves, pitchers, pitcher shape, and pitcher production, as seen often in F2 or more complex hybrids and also in the original Paroubek plants. It can also be observed that plants of this seed batch flower at a very small size, compared to their parents, and around the usual time for *Nepenthes* spp. to flower from seedlings, which is around 3 years. The type specimen of *N. robcantleyi* took approximately 10 years to flower and produced, as described, a flower spike said to rival *N. truncata* in dimensions at 1.4 meters in length (Cheek 2011).

There are many other characteristics that show that these *N. robcantleyi* F2 seedlings are actually a complex combination of *N. truncata* and *N. nebularum*. This being the case, the majority of seedlings that the authors have seen seem to be displaying more characteristics of the proposed parent *N. nebularum*, as would be expected, as *N. robcantleyi* and its putative parent also display some of these.

The most conspicuous differences are listed below:

1. Male and female inflorescences of the described *N. robcantleyi* are 2.13 m and 1.4 m respectively (Cheek 2011). The inflorescences on this progeny vary greatly with the largest we have observed between 0.8 m and 1.2 m. Most notably, the bracts on the partial peduncles are very unstable with both male and female flowers observed on this progeny with and without them.
2. The seedlings exhibit variability in pitcher color, from green to dark brownish to purple/black (Fig. 6). From what we have observed in many years of breeding *Nepenthes* spp., is if this color was stable, as in a similar dark colored species such as *N. izumiae*, there would be little, if any, variance, especially not the drastic variation seen in this progeny. Where we have produced primary hybrids using a pure species with dark red to black colored pitchers (as per the description of *N. robcantleyi*) such as *N. truncata* "green" × *ovata* and *N. izumiae* × *truncata* "green", all the progeny display this dark color. It seems to be a very dominant character when used in hybridization with a lighter colored species. However, we have seen many times, when we have bred with *Nepenthes* hybrids (both primary and complex) displaying black pitchers, the progeny produces pitchers that vary from green through to black. This

Figure 6: The above photo shows lids from different plants as detailed. It can be quite easily seen that the lids on the plants of *N.* × *robcantleyi* F2 show characteristics of both *N. truncata* and *N. nebularum* which is more evidence of the hybrid nature of *N.* × *robcantleyi*. Photos by Exotica Plants.

lack of dark pigment is also very much evident in the numerous hybrids that Borneo Exotics have produced with the typical *N. robcantleyi*.

3. The lid boss, which was used as a specific diagnostic character in the original description of *N. robcantleyi*, is not evident or diminished greatly in all the seedlings we have seen, which again aligns them more to the characteristics of *N. nebularum*.
4. The spur on the pitcher of the seedlings is another interesting feature that varies greatly. On two mature plants observed at Exotica Plants, the spur of one is 1.2 cm and the other is 4.5 cm (Fig. 7).
5. The leaf shape on many plants from this crossing have reverted somewhat to the truncated appearance of *N. truncata* and *N. nebularum*. The front of the leaf is more square rather than oblong-elliptic as described and seen in the line drawing in the description of *N. robcantleyi* and wider at the front as in *N. nebularum*.
6. The pitcher shape is another major difference in this progeny. The pitchers range from the squat (similar to those of the type specimen) to narrow green pitchers similar to those of *N. truncata* (Fig. 8).

Figure 7: The dramatic difference in spur length in just two of the progeny *N.* × *robcantleyi* of the crossing. Photos by Exotica Plants.

Figure 8: Two plants of *N. robcantleyi* progeny owned by Exotica Plants showing the notable differences in the pitchers and the lid deformation in the photo on the left. Photos by Exotica Plants.

7. The petioles of *N. nebularum* are velvety and the petiole wings are ferruginous villous where *N. robcantleyi* is described as glabrous to puberulent; *N. truncata* has very short hairs and the *N. robcantleyi* progeny is somewhere in between.
8. By comparing the pitcher lids of even a few plants, a combination of characteristics of both *N. nebularum* and *N. truncata* can easily be distinguished in the *N. robcantleyi* F2 plants (Fig. 6).

Referring back to the original question of stability of morphological characters of *N. robcantleyi*, we suggest that the answer is none. The peristome of *N. robcantleyi* varies from being flared to rolled back; the lid is seldom domed; the lid nectar gland distribution and stature is akin to that of *N. truncata*; the supposed presence of a lid boss is a reduced but still noted trait in both *N. nebularum* and *N. truncata*, and the presence *vs*. absence of partial peduncle bracts are both unstable; and its leaf acumen, coloration (albeit verging on the greens of *N. truncata* on F2 plants), persistent wings, peristome ribs and teeth development as well indumentum evokes those of *N. nebularum*. The difficulty in this situation is that the natural hybrid was described before one of its parents, and hence many people will have an understandable inclination to resist acceptance of *N. robcantleyi* to be a natural hybrid. If *N. nebularum* was described prior to *N. robcantleyi*, people would have had no difficulty interpreting *N. robcantleyi* as either a natural hybrid involving *N. nebularum*, or a variant of it.

Can it be seen as intermediate between *N. truncata* and *N. nebularum*? Yes, but interpreting *N. truncata* as a very variable species with *N. nebularum* as an extreme form of it would be going

too far, given the stable morphological traits and more or less stable ecological preferences of *N. nebularum* (see also Clarke & Moran 2011). To emphasize, it is our view that the seed parent is not the same entity as the "Royals" as they have unofficially been called in cultivation, and it may have been itself a product of natural hybridization. However, not knowing its history compels us to resort to Occam's razor and just refer to it as *N. truncata*.

N. truncata – highland?

While researching *N. truncata*, *N. nebularum*, and *N.* × *robcantleyi* for this article and as a slight aside from the main work, it was evident that the habitats of *N. nebularum*, the alleged *N.* × *robcantleyi* parent, and the *N. truncata* seen growing with it, were highland. They grew at an elevation of 1800 m asl. The interesting fact about this is that the *N. truncata* that Cantley saw growing with the *N.* × *robcantleyi* parent was very typical of this species that is usually known from lowland altitudes. In cultivation it has been our experience that this species from both elevations grows best in what would be classed as intermediate conditions. There has been unproven discussions about a morphologically distinct form of *N. truncata* from highland elevations over the years and, as also mentioned previously in this article, it was reported and posted on the Borneo Exotics website in 2004 as such. However, the plant displayed on Borneo Exotic's website was later described as the female parent of *N.* × *robcantleyi* and formally described as distinct from *N. truncata*.

Another plant claimed to also be a highland form of *N. truncata* is propagated and sold by a nursery in Germany. We believe that there is only one variant of this plant which has been in propagation for over 20 years and is described as *N. truncata* – "highland, reddish leaves". On seeing photos of mature plants and noting many similarities to *N. nebularum*, author, Geoff Mansell, contacted the nursery owner to establish the plant's origin, but was informed that the information had been lost. However further research was conducted. This was done by asking growers of this plant to send us close-up photos to study the plant's morphology, as well as the purchase of two plants, to establish if in fact it is a morphologically distinct form of the species or a distinct taxon. It is quite evident from the results and from our many years of experience hybridizing *Nepenthes* spp. that this plant from Germany falls into the parameters of a primary hybrid between *N. truncata* and *N. nebularum* (Fig. 9). The conspicuous characters demonstrated by this plant are part way between the two parents (Figs. 10 & 11). These are, the inner peristome pointed teeth-like projections, the lid keel and the front lid fold, pitcher wings, and the hirsuteness of the petiole, tendril, new leaf, and pitcher, with the pitcher also displaying the two distinct indumentum types. So to date, it seems that there has not been a highland form of *N. truncata* described or seen that has proven to be any different in its morphology than its lowland counterpart. Therefore in this respect, hobbyists cultivating this plant should be aware of this new information and if they agree with it and like to take it on its merit, this desirable plant should be renamed *N. truncata* × *nebularum*.

Therefore it seems that the alleged female parent of *N. robcantleyi* is a complex hybrid, showing stronger conspicuous characteristics of *N. nebularum* in its indumentum and lid appendages, yet it fails to show the strong inside teeth-like projections. The indumentum and lid appendages are clearly evident on the photo held at Kew Gardens (photo K) as part of the description, and which is also available at the following forum link at the time of writing; http://pitcherplants.proboards.com/thread/10684/black-truncata-new-species?page=12 . However it is more like *N. truncata* in its characteristics, as seen in its greater dimensions, smaller inside peristome teeth, terrestrial growth preference, as shown in the comparative photo held at Kew which was included in the *N. robcantleyi* protologue and, from what can be observed from the Kew photo, leaf structure.

Figure 9: We believe the above photos give credence to our suspicion that *N. truncata* - red leaf (right) is a natural hybrid between *N. truncata* (left) and *N. nebularum* (center). Photos by Exotica Plants and S. Gladisch.

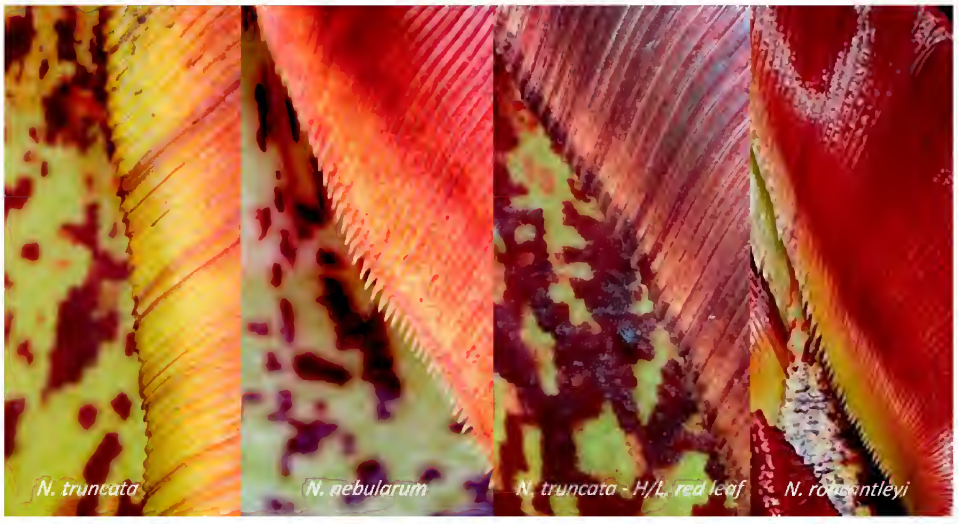

Figure 10: Comparison of the inner teeth-like projections on the peristomes of *N. truncata*, *N. nebularum*, *N. truncata* – highland, reddish leaves, and *N. robcantleyi*. Photos by Exotica Plants and A. Bianchi.

Figure 11: Comparison of the pitcher indumentum of *N. truncata*, *N. nebularum*, and *N. truncata* – highland, reddish leaves. Photos by Exotica Plants, A. Bianchi, and W. Suarez.

Conclusion

The images of the seed parent of *N. robcantleyi*, posted on the Borneo Exotics website, spurred the authors' suspicion that this taxon is a product of natural hybridization. But even without its existence, the hybrid nature of *N. robcantleyi* will eventually come into realization as more observations from the wild are being undertaken. Thomas Gronemeyer, who was in the first party that discovered the population of *N. nebularum* later visited by author Wally Suarez, also once remarked on a public forum, that "they were significantly smaller than the cultivated specimen", referring to the type of *N. robcantleyi*. As we have mentioned in the *N. nebularum* protologue, none of these wild plants (*N. nebularum*) ever exhibited the size and pitcher coloration of the *N. robcantleyi* seed parent.

The same seed parent, from the photo held at Kew, which is part of the basis for the *N. robcantleyi* description (Cheek 2011), grows as a terrestrial. Taking into account the importance of ecology in delimiting species (Clarke & Moran 2011), we would like to point out that *N. nebularum* is primarily epiphytic, but has been observed as a lithophyte too. This preference for growing above ground probably explains the compact aspects of *N. nebularum* plants. *Nepenthes truncata* may facultatively also grow as an epiphyte. However, Alastair Robinson postulated that environmental factors such as elevation and hydrology may compel these plants to also grow as terrestrials.

The circumstances that led to the description of *N. nebularum* involved the *in situ* observations from several field trips, of many individual plants, from multiple localities. In the same vein, inferences were augmented with study of cultivated plants of both *N. truncata* and *N. robcantleyi* from multiple sources from different countries, and author Geoff Mansell's extensive experiences in the

hybridization of various *Nepenthes* plants. All of these observations spanned years. Admittedly, the authors only had at their disposal two extant photographs of the *N. robcantleyi* seed parent, for obvious reasons. But even so, educated insights can already be assembled, especially when these same photos are viewed in a larger context involving the observations made on wild and cultivated plants involving the relevant taxa.

At the time of its description, *N. robcantleyi* was regarded as a true species by the vast majority in the *Nepenthes* community, and the possibility of it being of hybrid origin was expressed by a very limited few. The authors tested this hypothesis by patiently exploring all possible avenues and areas of contention for more than four years, and unequivocally arrived at the conclusion that there is, indeed, a previously unknown parent species to *N. robcantleyi*. We leave it to the reader to decide if what we have undertaken has been a worthy enterprise. If so, then the name *N. nebularum* is available, and *N. robcantleyi* can now be referred to as *Nepenthes* × *robcantleyi*.

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Observations of new *Roridula* symbiotes

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General overview of *Roridula* commensalism

The two species of *Roridula* are medium South African shrubs capable of trapping various small organisms on their resinous leaves. In its native range, the genus *Roridula* has been noted by various authors as having co-evolved with *Pameridea* spp. (Miridae) "mirid bugs" in an arrangement that allows the bugs to feed on the trapped insects, and for the plants to gain nutrients from the insects it traps via fecal fertilization courtesy of the mirid bugs (China & Carvalho 1951; China 1953). A third organism, a spider (*Synaema marlothii*), serves as a limiting factor on the *Pameridea* populations and is endemic to *Roridula* spp. in South African fynbos. This somewhat complex structure of inter-dependence was thought to be limited to the previously discussed three species through a textbook-perfect example of co-evolution and co-dependence between the aforementioned three organisms (Ellis & Midgley 1996). However, after recent observations by the author in Southern California, it appears that this commensal organization of [*Roridula* + Miridae + spiders] is less rigid in terms of which species participate than previously thought. In a broader sense, these and other to-be-discussed observations point to the idea that "assisted carnivory" in plants via generalist Miridae interaction is much more common than previously thought, and that mutualism between plants and Miridae bugs deserves greater scrutiny.

For example:

Native South African organization: (A) *Roridula dentata*/*gorgonias*, (B) *Pameridea roridulae*/*P. marlothii*, (C) *Synaema marlothii*.

Organization observed in Southern California: (A) *Roridula dentata/gorgonias,* (B) *Cyrtopeltis* sp. (Figs. 3 & 4), (C) *Peucetia longipalpis* (Figs. 1 & 2).

Roridula observations in Southern California

Over the course of the last 18 months (starting in September 2015), I have observed established, multi-generational populations of *Cyrtopeltis* sp. (Marsh 2016; Hand 2013) living on cultivated specimens of both *Roridula dentata* (a multi branched shrub ~1 m tall) and *R. gorgonias* (a small plant ~40 cm tall). This is a noteworthy observation, because according to Siggi Hartmeyer, a respected author on the subject, *Cyrtopeltis* are known to live on carnivorous plants with aqueous mucilage, while *Pameridea* are adapted to resinous glue, possessing an epicuticular greasy secretion to avoid sticking to the resin (Voigt & Gorb 2008; Hartmeyer 1996). On *Roridula*, these quick moving *Cyrtopeltis* insects are easily observed and are found most commonly around freshly-dead prey items, on the underside of leaves, or in leaf axils. The *Cyrtopeltis* average 4 generations of insects per plant per season, with population density peaking in the warmest summer months. Remarkably, as mentioned, observations conclude that these insects are completely uninhibited by the resinous glands of the *Roridula* plant that trap many other arthropods. The *Cyrtopeltis* nymphs tend to live closer to the main stem than adult counterparts. I have never seen *Pameridea* in person, but it appears that these *Cyrtopeltis* are inhabiting the exact ecological niche that has been exploited by *Pameridea roridulae* and *P. marlothii* in the veldts of South Africa.

Figure 1: *Peucetia longipalps* resting on *Roridula dentata* in Long Beach, California.

Figure 2: *Peucetia longipalps* and a shed skin, illustrating the fact that this spider does in fact live on, in, and amongst this *Roridula dentata* in Long Beach, California.

Figure 3: A *Cyrtopeltis* sp. nymph feeding on a prey item on a cultivated *Roridula dentata* in Long Beach, California.

Figure 4: A *Cyrtopeltis* sp. living on the underside of *Roridula gorgonias*.

In addition to the Miridae bugs, young *Peucetia longipalpis* spiders have been reliably observed living among my *Roridula* specimens. This species of spider appears uninhibited by the sticky glands of the *Roridula* plants. On my larger *R. dentata*, up to 2 spiders have been observed living together simultaneously. On my smaller *R. gorgonias*, only 1 young spider has thus far been observed. These *Peucetia* spiders weave minimal web structure, and instead wait for the plants to trap small flying insects. Notably, the spiders have invariably left the confines of the *Roridula* plants as their maturity develops. I have never observed adult *Peucetia* spiders on *Roridula*.

Whereas the *Cyrtopeltis* wait for the insects to die before swarming the body for consumption, *Peucetia* seem attracted to the vibrations of struggling prey, and rush to consume recently trapped insects. Interestingly, I have observed *Peucetia* preying on *Cyrtopeltis* nymphs which are unable to fly away from the larger predator. This behavior is similar to reports on the behavior of the native South African *Synaema marlothii* spider in relation to *Pameridea* bugs on wild *Roridula* stands (Lloyd 1934; Rice 2016).

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New cultivars

Keywords: cultivar, *Sarracenia* 'Brimstone', *Sarracenia* 'Giant Cotton', *Sarracenia* 'Iamsatyricon', *Sarracenia* 'Mercury', *Sarracenia moorei* 'Snow Lee', *Cephalotus* 'Round Leaf Big Daddy', *Dionaea muscipula* 'Alternance', *Dionaea muscipula* 'Lezard Vert'.

Sarracenia 'Mercury'

Received: 27 December 2016

Sarracenia 'Mercury' is a cross between my very first *Sarracenia*, a red form of *S.* × *areolata* (= *S. leucophylla* × *S. alata*) given to me for my birthday in 1991 and a *S. flava* that was sold to me by Marston Exotics as *S. flava* var. *maxima*, which after investigation turned out to be a cross between Slack's *S. flava* var. *maxima* and another *S. flava*. The seed was sown on 16 November 1994.

Sarracenia 'Mercury' has short pitchers usually about 35 cm tall which start off green with red veining and turn deep burgundy in full sun (Fig. 1). The pitchers are often retained during the winter and the flower is yellow. *Sarracenia* 'Mercury' is a hardy plant that requires a dormant period over winter so it can rest. If you are keeping it as a house plant put it somewhere unheated, in natural light, but do not let it dry out over winter. Keep the pot standing in a tray of rain water. It will survive outside in a sheltered location in the UK all year. The plant should only be propagated by division.

Sarracenia 'Mercury' was named on 12 April 2000 after the first planet of our solar system.

—Christopher Crow • Sarracenia Nurseries • 37 Stanley Park Road • Carshalton • Surrey SM5 3HT • UK • chris@sarracenianurseries.co.uk

Figure 1: *Sarracenia* 'Mercury'. Photo on right courtesy of James Ellis of Insektenfang, with permission.

Sarracenia 'Giant Cotton'

Submitted: 08 January 2017

Sarracenia 'Giant Cotton' is a hybrid of *Sarracenia leucophylla* 'Cronus' (trade-mark name *Sarracenia* Titan™) × a red *S. moorei*. I selected *Sarracenia* 'Giant Cotton' in 2016 from plants that I grew from seeds received from Cédric Azais in 2011.

There are two types of seasonal pitchers (Fig. 2). Spring pitchers grow to 70 cm tall with a little red color on its top. The autumn pitchers are white and about 90 cm tall and very strong. The hood is not very wide in relation to the size of the plant. The spring and autumn pitchers are so different that it would seem that they are from two different plants. The plant grows fairly quickly.

'Giant Cotton' was named in 2016 for the very tall size of the autumn pitcher and its white color.

Sarracenia 'Giant Cotton' must be reproduced vegetatively to preserve the unique characteristics of this cultivar.

—Olivier Bres • 90 Che. Montmirail • 84150 Violes • France • dionaeareddragon@aol.com

Figure 2: *Sarracenia* 'Giant Cotton' spring pitchers (left) and autumn pitchers (right). The shorter red-topped spring pitchers can also be seen in the center of the right photo between the two large white autumn pitchers.

Sarracenia 'Iamsatyricon'

Submitted: 17 January 2017

In the spring of 2009, I pollinated *Sarracenia* 'Leah Wilkerson' (received from Bruce Garcia in 2006) with *Sarracenia leucophylla* (L7 Mike King, obtained in 2003). Next autumn, the capsules were filled with hundreds of seeds. In the spring of 2010, during a visit to my greenhouse, I gave

many seeds of this hybrid to Marco Pezzilli and Alberto Bossi, two passionate friends and great growers of carnivorous plants that live in the vicinity of the city of Parma. Marco sowed the seeds immediately and after four years of cultivation in his greenhouse, a number of specimens with exceptional characteristics resulted.

But one in particular is the most beautiful and captures the attention: it is a brilliant *Sarracenia* with tall pitchers up to 80 cm, with a mouth which does not exceed 4 cm, finely pubescent, and velvety. The lid is wider, wavy and with a strongly marked edge of purple, with a subtle but firm grain, as if marked with ink (Fig. 3).

But it is the coloring that is its strong point: about a third of the top of the pitcher is almost completely white, pure white as fresh snow in the sun, brilliant, with very few well-defined veins in a network of purple. In the throat, the veins are sparse and bright white highlights a very marked pink spot, which resembles the shape of a moth, before descending into the trap.

The green part of the trap has the typical shades of *Sarracenia leucophylla*, then a green to gray, slightly pale and reflective when exposed to bright sun. The flower is 60 cm tall, almost completely red, with delicately edged petals of yellow orange.

A high environmental humidity during the period of growth and exposure to the intense and strong sun determines the best result for both the colors and for the growth of the plant.

The name, Iamsatyricon, is the nickname that Marco Pezzilli used on the web. Marco tragically died two years ago and his dad wanted me to take care of this plant, which was Marco's favorite, grown from the seeds I had donated in 2010. For me it is an honor to continue the life path of this beautiful specimen, remembering Marco.

Thanks to Alberto Bossi for the care with which he cultivates *Sarracenia* 'Iamsatyricon' perfectly in his greenhouse. To maintain and preserve the unique features of this specimen, propagation must take place only by division of the rhizome.

—Andrea Amici • via dei ciclamini 47 • 40043 Sirano di Marzabotto • Bologna • Italia • cephalotus@libero.it

Figure 3: *Sarracenia* 'Iamsatyricon'.

Sarracenia 'Brimstone'

Submitted: 19 February 2017

Sarracenia 'Brimstone' is a seed grown plant from a small batch of seeds that I received from UC Davis Botanical Conservatory (through the ICPS Seed Bank in December 2005) that were labeled "B2003.011 *Sarracenia flava* var. *atropurpurea* (not really pure *S. flava* - has orange flowers) × B2001.349 *Sarracenia alabamensis* ICPS location AL002". Since the *S. flava* seed parent was not really pure *S. flava*, there's no telling the exact overall parentage of *Sarracenia* 'Brimstone'.

Sarracenia 'Brimstone' is a fairly vigorous plant that readily spreads and clumps in cultivation, producing many pitchers throughout the growing season. The pitchers average about 45-50 cm in height in my growing conditions (which is hot and dry), but I have seen them reach 60 cm. The lid is wavy 8-10 cm long and protrudes over the mouth. Its exterior is a golden color and heavily veined in full sun. The pitchers start out a lime green with light veining, but quickly color up into a fiery orangey/red all throughout the upper pitcher, lip, and throat creating a very striking appearance with the golden, heavily veined lid as if the entire plant is on fire (Fig. 4). The pitchers are erect through the growing season and the flowers are produced in mass in the spring. The sepals of the flowers are a lime green edged in a sizzling red and the petals are a solid fiery red color also giving the appearance of flames (Fig. 4).

It is this flaming-like appearance of both the pitchers and flowers that inspired me in August 2010 to name this clone *Sarracenia* 'Brimstone'. This plant should be reproduced only by vegetative means to ensure that its unique characteristics are maintained.

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Figure 4: *Sarracenia* 'Brimstone' pitchers and flowers.

Sarracenia moorei 'Snow Lee'

Submitted: 17 March 2017

Sarracenia moorei 'Snow Lee' parents are *S.* 'Adrian Slack' × *S. leucophylla*. It has very beautiful pitchers with a white lid in summer and dense red veins in autumn (Fig. 5). The pitcher to lid ratio is perfect. It is vigorous with large pitchers and easy to grow.

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Figure 5: *Sarracenia moorei* 'Snow Lee'. Summer pitchers have a white lid with red veins (left). Autumn pitchers are more colorful with dense red veins (right).

Cephalotus 'Round Leaf Big Daddy'

Submitted: 6 March 2017

In 2007, I bought a well grown *Cephalotus follicularis*. I coined the name *Cephalotus* 'Round Leaf Big Daddy' several years ago and I have been able to establish this particular clone into many private collections around the globe! Pitchers can be 5 cm tall and fat, 3 cm wide (Fig. 6). The non-carnivorous leaves are nearly round, up to 3 cm in diameter (Fig. 7). The plant stays mostly green in summer, but with cold temperatures it becomes dark maroon.

Figure 6: *Cephalotus* 'Round Leaf Big Daddy' pitchers are tall and fat.

Figure 7: The non-carnivorous leaves of *Cephalotus* 'Round Leaf Big Daddy' are nearly round. The plant is mostly green during summer, but becomes dark maroon when the temperatures drop in the fall.

My growing experience has been indoor in an unheated garage with 12 hours of artificial light. For me a potting mixture of 50% peat and 50% pine bark works fine. The substrate should always be damp and well drained. The plant has a dormant period as usual for *Cephalotus* when the temperature drops and starts the growing period again when the weather warms.

To preserve the unique characteristics of the plant, propagation must be vegetative. Almost any part of the plant can be used, including the roots, but I use the non-carnivorous flat leaves. It is easy and efficient. I put the leaves in the same pot as the mother plant and when the new plant emerges, it can be removed to its own pot. This cultivar is a very good grower. It usually takes about 1 year for plantlets grown from leaf cuttings to reach adult pitchers.

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Dionaea muscipula 'Lezard Vert'

Submitted: 28 March 2017

Dionaea muscipula 'Lezard Vert' is from seed germinated in 2014. The petiole has a series of pronounced crests that extend to the inner edges of the trap and to each side (Fig. 8), giving it the appearance of a green lizard (lezard vert). This cultivar is similar to *Dionaea* 'Schuppenstiel II'. What differentiates it are the prominent and constant crests. They do not tend to disappear at a certain time of the year or following the exposure to light. The plant is constantly prostrate, the eyelashes tend to merge.

Reproduction must be vegetative by leaf cuttings or division of the rhizome.

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Figure 8: *Dionaea muscipula* 'Lezard Vert'.

Dionaea muscipula 'Alternance'

Submitted: 28 March 2017

Dionaea muscipula 'Alternance' is from seed germinated in 2014. The trap has two rows of teeth alternating one to the left and one to the right (Fig. 9), hence its name of *Dionaea* 'Alternance' coined in March 2017. The entire plant has a rather yellow background. The inner color of the trap is rose red. In full sun, the plant becomes greener and the trap becomes redder.

The plant is stable and reproduction must be vegetative by leaf cuttings or division of the rhizome.

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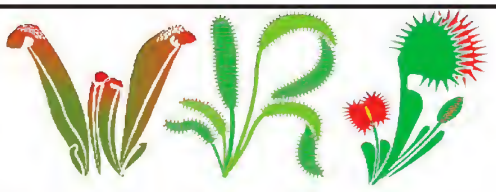
Figure 9: *Dionaea muscipula* 'Alternance'. Early yellowish trap (top left); redder trap and plant grown in full sun (top right and bottom).

Carnivorous plant cultivar names registered in 2016

Name	Publication	Date
Cephalotus 'Bananito' E.Piacenti	Carniv.Pl.Newslett.45:77 (2016)	30 Nov.
Dionaea 'Coquiton' A.Letertre	Carniv.Pl.Newslett.44:214 (2016)	23 Jan.
Dionaea 'Shark Mirror' A.Letertre	Carniv.Pl.Newslett.45:120 (2016)	23 Dec.
Drosera 'Alexandrite Aster' H.Carlton	Carniv.Pl.Newslett.45:119 (2016)	23 Dec.
Drosera 'Anemone' H.Carlton	Carniv.Pl.Newslett.45:74 (2016)	30 Nov.
Drosera 'Childhood Wishes' H.Carlton	Carniv.Pl.Newslett.45:118 (2016)	23 Dec.
Drosera 'Eclat' A.Schram	Carniv.Pl.Newslett.44:213 (2016)	23 Jan.
Drosera 'Pilliga Red' R.P.Gibson	Carniv.Pl.Newslett.45:77 (2016)	30 Nov.
Drosera 'Scarlet Tears' H.Carlton	Carniv.Pl.Newslett.45:75 (2016)	30 Nov.
Nepenthes 'Autumn Wine' H.Carlton	Carniv.Pl.Newslett.45:75 (2016)	30 Nov.
Nepenthes 'Guillermo Reyes' A.Bostrom	Carniv.Pl.Newslett.44:215 (2016)	23 Jan.
Sarracenia 'Ares' J.Addington	Carniv.Pl.Newslett.45:73 (2016)	30 Nov.
Sarracenia 'Bug Bat' L.Mellichamp	Carniv.Pl.Newslett.45:124 (2016)	23 Dec.
Sarracenia 'Carolina Yellow Jacket' L.Mellichamp	Carniv.Pl.Newslett.45:125 (2016)	23 Dec.
Sarracenia 'Chris' S.Morley	Pl.Carniv.37(2):7 (2016)	26 Mar.
Sarracenia 'Fat Chance' L.Mellichamp	Carniv.Pl.Newslett.45:126 (2016)	23 Dec.
Sarracenia 'Freja' S.Morley	Pl.Carniv.37(2):23 (2016)	26 Mar.
Sarracenia 'Hot Lips' P.Faulisi	Carniv.Pl.Newslett.45:121 (2016)	23 Dec.
Sarracenia 'Leigha Simone' E.Morrow	Carniv.Pl.Newslett.45:34 (2016)	14 May
Sarracenia 'Saurus' P.Faulisi	Carniv.Pl.Newslett.45:122 (2016)	23 Dec.
Sarracenia 'Sword Swallower' P.Faulisi	Carniv.Pl.Newslett.45:123 (2016)	23 Dec.
Utricularia 'Brazilian Beauty' G.Bourke	Carniv.Pl.Newslett.45:33 (2016)	14 May



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